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HELIUM COOLED FLIBE BLANKET

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2.5.2.2 Helium Cooled Flibe Blanket

The blanket design uses a pressure vessel to contain the 50 atmosphere helium gas. Helium cools the first wall and blanket internals. The internals consist of a bed of beryllium balls nominally 1 cm diameter in which neutrons are multiplied and later captured, breeding adequate (even excess) amounts of tritium and releasing energy in exothermic nuclear reactions. Tritium is bred in the molten flibe salt which flows slowly (0.1m/sec) in steel tubes. The salt is kept reducing by periodic reacting with beryllium so the tritium will be in the T_2 form, however with somewhat enhanced corrosion rate the salt could be kept oxidizing in which case the tritium would be in the TF form. To prevent the tritium from permitting too much into the helium stream, a tungsten coating on the inside of the tubes is proposed. Tritium is removed from the salt and helium by processing both. Because the solubility of tritium in Flibe is so low, there will be a strong driving force for tritium permeation and this places a great burden on a high integrity tungsten permeation barrier. The tritium in the helium is prevented from permeating excessively into the steam system by jacketing the steel steam generator tubes with a 1 mm aluminum jacket. Clearly, tritium containment and barrier development are the most important feasibility issues for this design.

Flibe will not react with air or water. This has safety advantages with respect to large accidents such as a lithium-water accident. However, the safety evaluation did not weigh heavily large accidents. Flibe is not easy to clean up after a spill because it is insoluble in water and this together with fluorine activation and the tritium permeation made this blanket score rather poorly on safety.

The energy multiplication of this blanket was the largest of the various designs due to the extensive use of beryllium and this gave 20 to 30% more power production for the same fusion power. The economic evaluation scoring of Flibe was not high inspite of this extra energy due in part to the high pumping power and the low exit temperature both of which could be improved in an optimized design.

Beryllium in the form of pebbles was chosen because by fluidizing, the beryllium can be loaded into the blanket after manufacturing and the beryllium balls can be moved periodically to accommodate radiation induced swelling. Once the balls have reached their radiation damage lifetime, they can be fluidized and removed from the blanket for refabrication and recycle. Since

the recycled beryllium would be radioactive, relatively simply recycle operations allowed by pebble form keep costs of remote manufacture from becoming prohibitive.

In summary, the Flibe design looks feasible. If adequate barriers cannot be achieved, the oxidizing state of the salt would be employed to retain tritium as TF. The use of beryllium, made more feasible by employing a pebble form, results in significant potential economical advantages not however seen in the particular design evaluated. The design did not score highly on safety but appears to cope with accidents by passive means and inherently cannot have a "large accident" due to the low chemical reactivity of the blanket materials.